ABITIBI GEOPHYSICS

# KODIAK EXPLORATION LTD.

GROUND GRAVITY SURVEY

**HERCULES - CENTRAL GOLDEN MILE PROJECT**

**ELMHIRST TOWNSHIP**

NORTHERN ONTARIO, CANADA

08N052 JUNE 2008

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## ABSTRACT

*On behalf of Kodiak Exploration Ltd., a ground gravity survey was carried out over the Kinghorn area, located on the West of Geraldton, Northern Ontario, Canada. The aim of this geophysical campaign was to delineate the gold bearing zone located in the Kinghorn road site.*

*Between May 9th and May 19th 2008, a total of **439 gravity readings** with 25 m x 50 m, 50 m x 50 m and 100 m x 100 m nominal sampling were recorded using two CG-5u Autograv gravimeters (Scintrex) and positioned in DGPS fashion using double frequency Leïca systems ATX 1200. Survey specifications, instrumentation control, data acquisition and processing were all successfully performed within our Quality System framework.*

*The estimated total error on the Bouguer anomaly before inner terrain correction is 0.022 mGal, which is better than the contract requirement (0.050 mGal).*

*This gravity survey could not identify the quartz veins style mineralization, but was able to locate higher density dyke-like bodies, also seen from the existing magnetometric data. In order to identify the quartz vein style mineralization, it would be recommended to perform an IP survey in the gradient and dipole-dipole configuration.*

# 1. THE MANDATE

- ***PROJECT ID*** — **Hercules - Central Golden Mile Project**
  (Our reference: **08N052**)

- ***GENERAL LOCATION*** — Approximately 73 km west of Geraldton, Ontario, Canada.

- ***CUSTOMER*** — **Kodiak Exploration Ltd.**
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  Vancouver BC, Canada V6C 1G8
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- ***SURVEY TYPE*** — Detailed ground gravity survey with 25 m x 50 m, 50 m x 50 m and 100 m x 100 m nominal sampling.

- ***GEOPHYSICAL OBJECTIVE*** — Detected the quartz veins style mineralization associated within gabbro formation embedded in a cashing of granodiorite.


FIGURE 1: GENERAL LOCATION OF THE HERCULES - CENTRAL GOLDEN MILE PROJECT

## 2. The Hercules - Central Golden Mile Project

| | |
|---|---|
| ❑ *Location* | **Kinghorn**, Ontario, Canada<br>Centred on 49°49' N and 87°40' W<br>NTS map number: **42E/13** |
| ❑ *Nearest settlement* | Jellicoe: 38.8 km to the south-east. |
| ❑ *Access* | From Geraldton, go west for approximately 40 km, then take the Kinghorn Road to the north direction. The survey grid isolated 32.5 km to the NW. |
| ❑ *Geomorphology* | The survey area has no topography and is swampy. |
| ❑ *Cultural features* | No artificial structures were encountered throughout the grid. |
| ❑ *Land Tenure* | The claim numbers encompassed in the present survey are illustrated on the following page. All the claims belong at 100% to Kodiak Exploration Ltd. |
| ❑ *Survey grid* | The main survey grid consists of sixteen NE-SW lines from 11+00W to 18+50W, 50 m apart. Gravity readings were collected every 25 m on the central part and 50 m on the edges.<br><br>Lines 12+00W, 13+00W and 14+00W spaced at 100 m were extended 0.98 km to the NE and 1.72 km to the SW away from the edge of the grid, and were sampled every 100 m. |
| ❑ *Coordinate system* | Projection : Universal Transverse Mercator (UTM)<br>Datum : NAD 83<br>Zone : 16N |

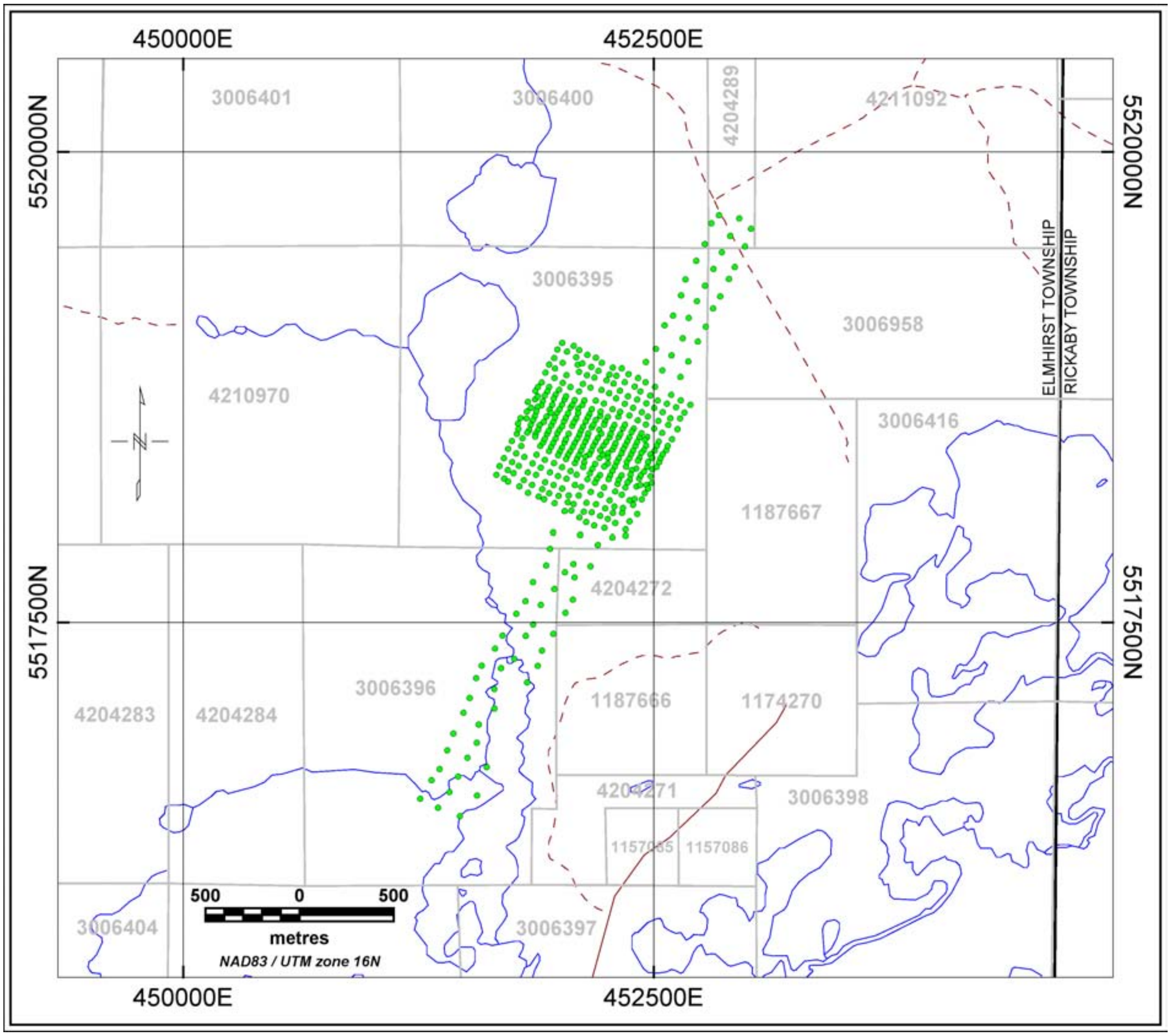


FIGURE 2. INDEX OF CLAIMS AND SURVEY COVERAGE ON THE HERCULES - CENTRAL GOLDEN MILE PROJECT

# 3. GRAVITY DATA ACQUISITION

| | |
|---|---|
| ❑ *TYPE OF SURVEY* | Detailed gravity survey with expected accuracy better than 0.05 mGal in the Bouguer anomaly (before terrain corrections). |
| ❑ *PERSONNEL* | François Dubé, GPS specialist<br>Annie Lacasse, BSc., Map processing, final drafting<br>Madjid Chemam, MASc, QC and supervision<br>Zoheir Hamzaoui, BSc., QC and interpretation<br>Steve Boucher, Eng, Final validation of product conformity |
| ❑ *FIELD CREW* | Zoheir Hamzaoui, Gravimeter 344 operator<br>Marcel Naud, Gravimeter 430 operator<br>Yohan Lanoix, GPS operator<br>Alexandre Mecteau, GPS operator |
| ❑ *SURVEY COVERAGE* | **439** stations, including two base stations and excluding all the re-visited stations. |
| ❑ *DATA ACQUISITION* | May 9th to May 19th, 2008 |

❑ *INSTRUMENTATION*

| | |
|---|---|
| Type: | **Scintrex CG-5u Autograv** |
| Reading resolution: | 0.001 mGal (digital recording) |
| Serial numbers: | 980890**430** (430)<br>961090**344** (344) |
| Calibration constant: | $K_{344}$ = **1.000212** mGal / unit<br>$K_{430}$ = **1.000139** mGal / unit<br>Enabled |
| Seismic filter: | Enabled |
| Continuous tilt correction: | Enabled (*threshold is 6 x standard deviation with seismic filter on)* |
| Auto rejection: | Enabled |
| Tide correction: | Enabled |
| Read time: | 2 to 4 cycles of 60 seconds. |

❑ *SOFTWARE*

**SCTutil** (Scintrex) for data transfer to a PC.
**Xcelleration** (Oasis Montaj module from Geosoft) for all remaining gravity processing.

❑ *BASE STATION*

The survey is tied to the Canadian Gravity Standardization Network (CGSN). A local base station (***Kinghorn*** **#9999**) was chosen on a flat rocky outcrop (see the description at page 7 and 8).

❑ *FIELD PROCEDURES*

Each loop began and ended with a reading at the ***Kinghorn*** base station. These readings were used to calculate the instrumental drift. A drift correction was then linearly applied to the data in the loop.

At each station, the following parameters were recorded in the field notebook:

- Station identification
- Local time
- Standard deviation of each gravity reading
- Instrument height above ground
- Instrument readings

- Slopes to the centre of each four Hammer zones sectors B (2-12 m) and C (12-50 m).

The following data was recorded in the instrument's memory:

- Station identification
- Instrument readings
- The standard deviation of each reading
- Tilt about the X axis in arc-seconds, at the end of the reading
- Tilt about the Y axis in arc-seconds, at the end of the reading
- The gravity sensor temperature compensation factor
- The tide correction for each reading
- The number of samples that were read
- The number of rejected samples
- Local time

The first step was to locate the most appropriate site for both GPS and gravity readings. The gravity meter was then placed on the tripod and the meter was levelled with the levelling screws on the tripod before the reading was initiated; the operator stayed still to avoid inducing ground motion that could affect the gravity meter.

The gravity meter was put in its padded and insulated carrying bag immediately after each reading was taken.

After each survey day, the data was downloaded from the CG-5 gravimeter through an USB cable to a computer. The Scintrex ***SCTutil*** program was used to transfer the data.

| Kodiak Exploration Ltd. | | Figure 3 : Gravity base station |
|---|---|---|
| Station number: | **9999** |  |
| Name: | Kinghorn | |
| Area: | Kinghorn, Ontario | |
| NTS sheet: | **42E/13** | |
| Geodetic system: | NAD 83, UTM Zone 16N | |
| Longitude: | 87° 37' 16.86038" W | |
| Latitude: | 49° 47' 38.71708" N | |
| Easting: | 455 279.898 ± 0.005 mE | |
| Northing: | 5 515 922.079 ± 0.005 mN | |
| Elevation (Ht2.0): | 332.090 ± 0.007 m | |
| $g_{ABS}$ (calculated): | **980925.2045** mGal |   |
| Primary station: | tied to the CGSN | |
| Gravimeter: | N/A | |
| Positioning: | Leïca DGPS | |
| From the intersection of Highway 11 and Kinghorn Road, the gravity base station is located on the left, at 29.1 km, on a flat rocky outcrop. | | |

FIGURE 3. KINGHORN GRAVITY BASE STATION DESCRIPTION

| Kodiak Exploration Ltd. | |
|---|---|
| Station number: | **9239-1976** |
| Name: | Pearl |
| Area: | Pearl, Ontario |
| NTS sheet: | **52A/10** |
| Geodetic system: | NAD 83, UTM Zone 16N |
| Longitude: | 88° 39' 33" W |
| Latitude: | 48° 39’ 53" N |
| Easting: | 377 834.064 mE |
| Northing: | 5 391 513.949 mN |
| Elevation: | 253 m |
| $g_{ABS}$ | **980822.410** ± 0.020 mGal |
| Primary station: | CGSN |
| Gravimeter: | N/A |
| Positioning: | N/A |

Station is located on the bridge over the Pearl River, on Highway 17, on the NE corner of the concrete structure. The station is indicated by an aluminium plate.

**Figure 4: Canadian Gravity Standardization Network (CGSN)**


FIGURE 4. PEARL GRAVITY BASE STATION DESCRIPTION

- *GRAVITY QC'S*

**Before the survey:**

- ✓ The gravity meter had been heated and stabilized for more than a week.
- ✓ All the internal constant values had been checked.
- ✓ Temperature compensation had been fine-tuned to ± 0.1 mGal/mK.
- ✓ The X and Y tilt sensitivities had been checked and did not require any adjustments.

**During the survey:**

- ✓ The drift was controlled after each loop. The absolute average closure error was found to be:

| Drift (mGal) | Contract Requirements | Observed | |
|---|---|---|---|
| | | Meter 344 | Meter 430 |
| Per loop | 0.100 | **0.042** | **0.029** |
| Per hour | 0.010 | **0.005** | **0.004** |

A chart of the residual cumulative drift for each meter is presented on the next page.

- ✓ While readings were recorded, the operator observed the tiltmeter to ensure that the instrument stayed levelled well within ± 15 arcsec range.
- ✓ At least two readings were taken at every station. A third and even fourth one was recorded if the first two were more than 0.01 mGal apart.

**At Operation Headquarters:**

- ✓ Dump files (YYMMDDG.txt) were inspected to detect any spurious readings, for instance:
  - reading time < 60 seconds
  - standard deviation > 0.1 mGal
  - rejected samples > 5

**40** stations out of **439** (9.1%) were re-occupied in a different traverse. The average repeat error on the absolute gravity $g_A$ was **0.011** mGal and the root main square (rms) was **0.007** mGal.

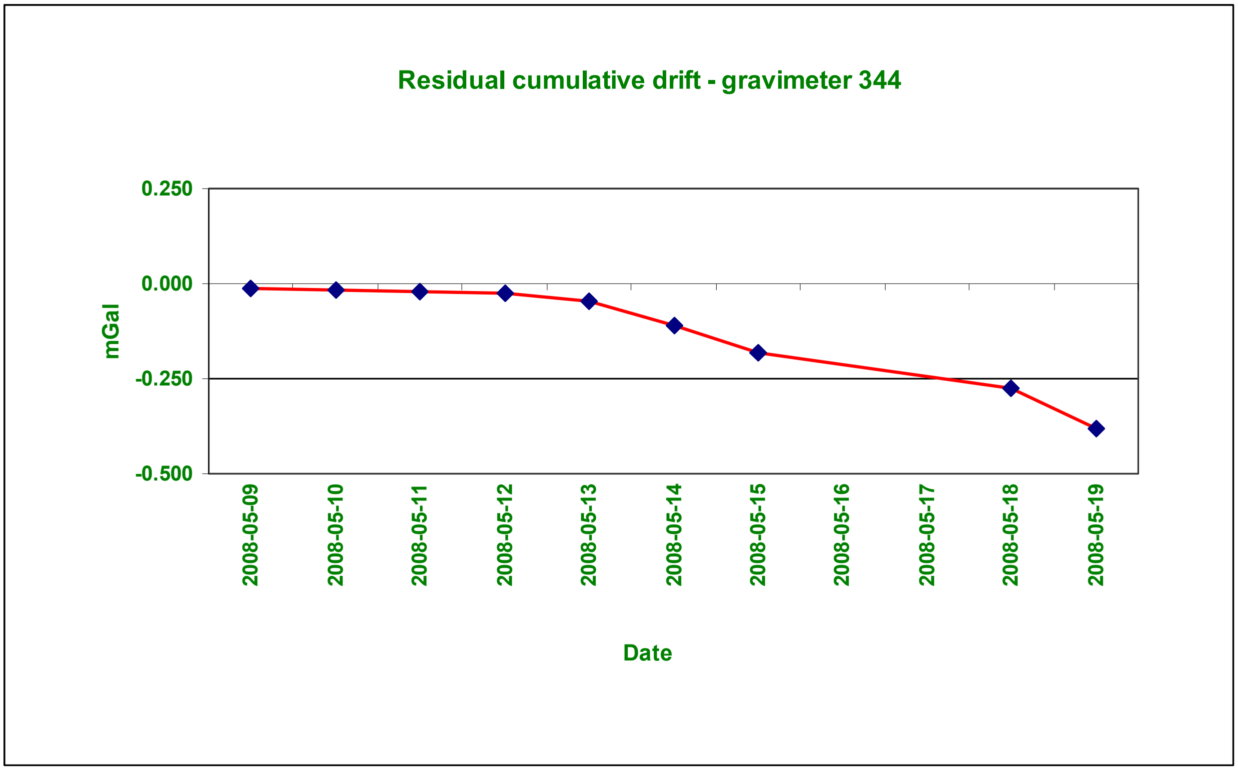


FIGURE 5. RESIDUAL CUMULATIVE DRIFT FOR GRAVIMETER 344

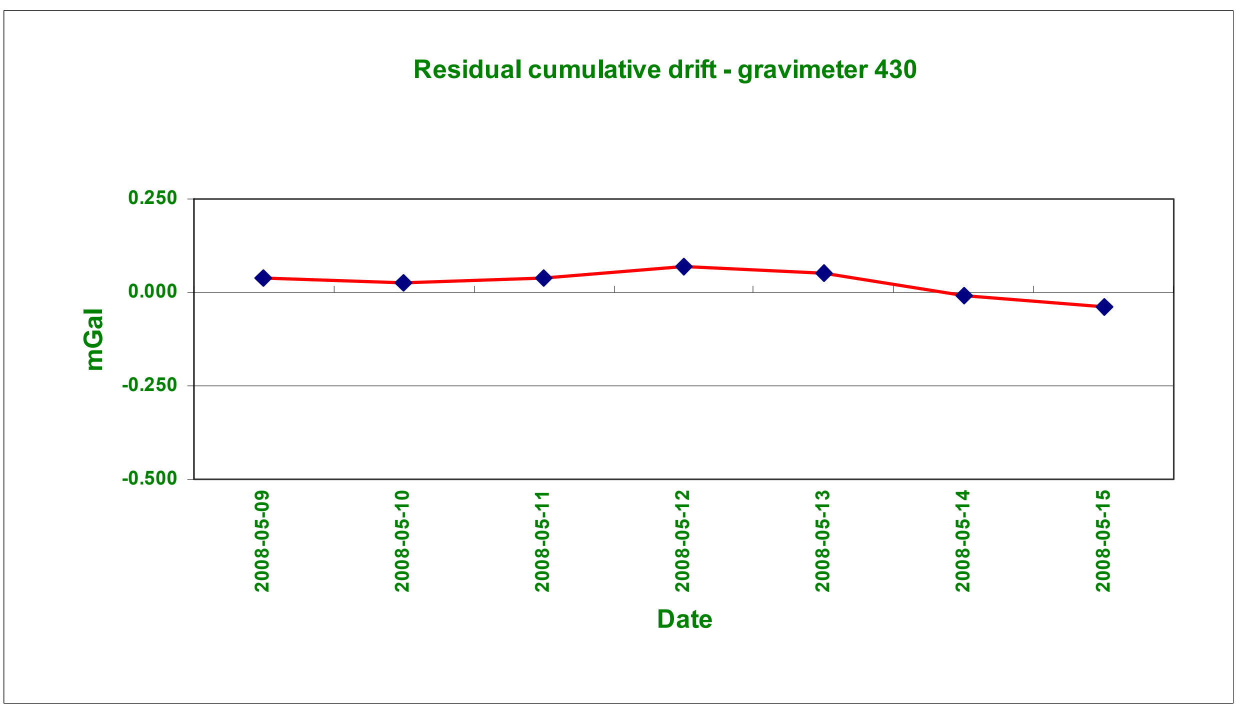


FIGURE 6. RESIDUAL CUMULATIVE DRIFT FOR GRAVIMETER 430

## 4. GPS DATA ACQUISITION

- *TYPE OF SURVEY* — Real Time Kinematic (RTK) GPS surveying from an arbitrary point with an expected accuracy better than 5 cm in elevation and horizontal positioning.

- *INSTRUMENTATION*

| | | |
|---|---|---|
| Base station : | Leïca ATX1200 : | s/n 114434 |
| Mobile: | Leïca ATX1200 : | s/n 307021 |
| Mobile: | Leïca ATX1200 : | s/n 307668 |

All the Leïca units are dual frequency (L1 & L2) with phase measurements in order to maximize the number of observations and thereby improving the resolution of ambiguities.

- *SOFTWARE* — LEICA Geo-Office 4.0 from Leïca.

- *COORDINATE SYSTEM*

| | |
|---|---|
| Projection : | UTM Zone 16 |
| Type : | Transverse Mercator |
| Datum : | NAD83 Canada, Central North America |
| Central meridian : | 87°00' W (UTM Zone 16) |
| Central scale factor : | 0.9996 |
| False easting : | 500 000 m |
| False northing : | 0 m |
| Ellipsoid : | GRS 1980 |
| Geoïd model : | HT2 |

- *GPS BASE STATION* — A non-monumented, arbitrary GPS base station network was established and used for the survey duration. Dual frequency time-tagged information from the satellite signal was transmitted via radio link to the mobile.

- *GPS PROCESSING* — The coordinates were processed and recorded in real-time (on the field) with the radio information transmitted by the base station. Data was downloaded from the GPS PCMCIA cards to a computer and checked after each survey day.

- *GPS QC'S*

**Before the survey:**

- ✓ The GPS units were verified against three provincial calibration benchmarks in Val-d'Or.
- ✓ Level and graduated staff accuracies were checked.

**During the survey:**

- ✓ The distance between the antenna and the ground was measured, to a precision of 1 millimetre, and was then entered on the keypad.
- ✓ The gravity station number was manually incremented on the keypad-display unit and then checked against the number recorded in the gravity meter.
- ✓ Simultaneously recording for the duration of the reading.

**At Operation Headquarters**:

- ✓ The average precision of the elevation values as determined by *LEICA Geo-Office* 4.0 is **1.8 cm** with a standard deviation of **0.7 cm**. The maximum value was found to be **6 cm** at stations **2021** and **2198**.

- ✓ The average precision on the horizontal positions (X & Y) is **1.2 cm** with a standard deviation of **0.5 cm**.
- ✓ Re-visited stations were daily processed to identify any possible weakness in the survey method. 40 stations out of 439 were re-visited **(9.1%)**. The average absolute error on the elevation was calculated to be **0.7 cm** with a root mean square (rms) of **0.8 cm**. The maximum value was found to be **2.9 cm** at station **2103.**

# 5. DATA PROCESSING AND DELIVERABLES

❒ *ABSOLUTE GRAVITY ($g_A$)*

The observed gravity values (YYMMDDG.txt files) were first imported into Geosoft Xcelleration along with the elevation data. In view of the high accuracy of the gravity readings, the root mean square (rms) on the observed gravity was estimated **0.007** mGal.

Tidal correction is re-calculated in Xcelleration using the station location and measuring time. The accuracy of this correction is better than **0.001** mGal.

The value of the instrument height is typically accurate within ± 2.0 cm or ± **0.006** mGal.

The residual drift of the gravimeter is assumed linear between two readings at the base station. The closure error was linearly distributed on the data in the corresponding loop, taking into account the instrument height and the tidal correction. Non-linear drifting could introduce an error of up to **0.005** mGal in the middle of a loop.

The maximum error on $\mathbf{g_A}$ is therefore estimated to be ± **0.019** mGal.

❒ *BOUGUER ANOMALY ($g_B$)*

**Density "ρ"**: a value of **2.67** g/cm$^3$ local crustal density was taken for the Bouguer and terrain corrections.

**Latitude Correction**: both the rotation of the Earth and its slight equatorial bulge produce an increase of gravity with latitude. This effect is corrected when computing the theoretical value of gravity at the surface of the reference ellipsoid using the Geodetic Reference System GRS67:

$$g_L(\phi) = 978\,031.846\,\{1.0+0.005278895 \sin^2(\phi) + 0.000023462 \sin^4(\phi)\}\ \text{mGal}$$

The horizontal position is accurate to better than ± 5 cm, so the error is less than **0.001** mGal.

**Free Air Anomaly**: since gravity varies with the inverse of distance squared, it is necessary to correct for changes in elevation between stations so that all field readings are reduced to a datum surface. The Free Air anomaly at elevation "h" is:

$$g_F = g_A - g_L + 0.308596 * h$$

**Bouguer Anomaly corrected for overburden**: it accounts for attraction of bedrock of density "ρ" between the station and the datum plane, which was ignored in the Free Air calculation. The Bouguer anomaly is:

$$g_B = g_F - 0.0419088 * \rho * h.$$

Using a density of 2.67 g/cm$^3$ and a typical accuracy of ± **1.8 cm** in elevation, the error on the combined Free Air and Bouguer correction is **± 0.004** mGal.

## ❒ ACCURACY OF $g_B$

| Step | Source / Evaluation Method | Error (mGal) | |
|---|---|---|---|
| | | Maximal | Typical |
| $g_A$ | Re-occupied stations | 0.019 | 0.007 |
| $g_L$ | Latitude correction | 0.001 | 0.000 |
| $g_B$ | Free Air and Bouguer | 0.011 | 0.004 |
| **Estimated error on $g_B$ *** | | **0.022** | **0.008** |
| Contract requirement * | | 0.050 | 0.050 |

* excluding terrain correction,

$g_B = \pm \left( \sqrt{g_A^2 + g_L^2 + g_B^2} \right)$, mGal

## ❒ TERRAIN CORRECTION

It allows for surface irregularities in the vicinity of the station, not accounted for in the Bouguer calculation. An excess mass in the form of a positive topographic feature adjacent to a gravity station exerts an upward pull on the gravity meter, thus lowering the observed reading. A mass deficiency in the form of a valley adjacent to a gravity station causes the gravity field to be lower than it would be where the terrain is flat. Terrain corrections compensate for these effects and are therefore always positive.

***Inner Terrain Correction*** (ITC):
The ITC, which corrects for local topographic features (terrain effect up to 50 m from the station), is performed using the Hammer method (Geophysics, 1939). This method involves creating a set of concentric rings, or zones as they are referred to here, each of which is divided into a specified number of equal-sized segments. The average elevation for each of these segments is entered relative to the elevation specified for a given station. In this way, the topography immediately surrounding each station can be defined and the inner terrain correction calculated:

$$g_T = \gamma * \rho * \theta * \left( r_2 - r_1 + \sqrt{r_1^2 + z^2} - \sqrt{r_2^2 + z^2} \right)$$

Where $\gamma$ = 6.67x10$^{-8}$ dyne cm$^2$/g$^2$
$\theta$ = sector angle (in radians)
$\rho$ = density (in g/cm$^3$)
$r_1$, $r_2$ = inner and outer sector radius (in cm)
z = average height difference between the station and the sector (in cm)

| | Zone B | Zone C |
|---|---|---|
| $r_1$: | 2 m | 12 m |
| $r_2$: | 12 m | 50 m |
| Number of sectors: | 4 ($\theta$ = 1.57) | 4 ($\theta$ = 1.57) |

***Outer Terrain Correction*** (OTC):
The OTC, which corrects for more distant topographic features, is performed using one or more external grids containing digital elevation models (DEM) for the area interest. On the Kinghorn area the OTC is not applied.

- *BOUGUER ANOMALY*

The complete Bouguer gravity anomaly corrected for the inner terrain correction was calculated employing standard reductions using a bedrock density value of **2.67** g/cm$^3$ with Oasis Montaj. The entire database was gridded using a minimum curvature algorithm with a grid cell size of 12.5 m and then was regrided at 10 m. Two passes of a Hanning 3x3 filter was then applied to the grid. The Oasis Montaj color table (Clra64.tbl) was used with linear intervals of 0.02 mGal from -60.44 to -59.18 mGal.

- *REGIONAL ANOMALY CONTOURS*

Regional anomaly contours map was obtained by using a second degree polynomial surface. The database was gridded using a minimum curvature algorithm with a grid cell size of 10 m. The Oasis Montaj color table (Clra64.tbl) was used with linear intervals of 0.02 mGal from -60.40 to -59.28 mGal.

- *RESIDUAL ANOMALY CONTOURS*

The residual anomaly profiles were done by substracting the Regional from the Bouguer anomaly. The database was gridded using a minimum curvature algorithm with a grid cell size of 10 m. The Oasis Montaj color table (Clra64.tbl) was used with linear intervals of 0.01 mGal from -0.32 to 0.32 mGal.

- *VERTICAL GRADIENT CONTOURS*

The vertical gradient map was gridded at 10 m cell size using a minimum curvature algorithm. The Oasis Montaj color table (Clra64.tbl) was used with linear intervals of 0.0002 mGal/m from -0.006 to 0.006 mGal/m.

- *MAPS PRODUCED*

Colour maps of the Bouguer gravity anomaly, elevation contours, regional anomaly contours, residual anomaly contours and vertical gradient anomaly contours were produced at a 1:5000 scale, and are inserted in pouches at the end of this report.

Our Quality System requires that every final map be inspected by at least two qualified persons before being approved and included in a final report.

| Map Number | Description | Scale |
|---|---|---|
| 2.2 | Ground Gravity Survey – Bouguer Anomaly Contours (mGal) | 1:5000 |
| 2.3 | Ground Gravity Survey – Elevation Contours (m) | 1:5000 |
| 2.4 | Ground Gravity Survey – Regional Anomaly Contours (mGal) | 1:5000 |
| 2.5 | Ground Gravity Survey – Residual Anomaly Contours (mGal) | 1:5000 |
| 2.7 | Ground Gravity Survey – Vertical Gradient Anomaly Contours (mGal) (Convolution Filter Method) | 1:5000 |

- *DIGITAL DATA*

The above-described maps are delivered in the Oasis Montaj map file format on CD-Rom.

A copy of all calibration data, survey acquisition data (ASCII text format) and gravity-processed data (Geosoft Montaj databases) are also delivered on CD-Rom.

# 6. SURVEY RESULTS AND RECOMMENDATIONS

The resulting gravity anomaly was calculated employing standard terrain correction in Oasis Montaj using a bedrock density of 2.67 g/cm$^3$. The resulting Bouguer map contoured at 0.02 mGal interval is shown on map 2.2. The Bouguer anomalies range in values from -60.44 mGal to -59.18 mGal (average -59.82 mGal). The highest values are recorded in two parts of the area: (1) in the western part of the grid along lines 15+00W, 18+50W and tie line 9+00S, (2) in the north-eastern part of the grid.

❐ *REGIONAL AND RESIDUAL ANOMALIES*

To isolate the local gravity anomaly from the regional, a second degree polynomial surface was calculated to approximate the regional gravity (see map 2.4). This regional anomaly was subtracted from the Bouguer gravity map in order to obtain the residual gravity anomaly (map 2.5). The first vertical derivative is another efficient interpretation technique which is often recommended to validate the residual anomaly gravity calculated with a polynomial method

In spite of some differences in shape and in amplitude of the residual gravity anomalies, both interpretation methods have commonly identified some structures that may indicate the presence of mafic intrusion bodies.

❐ *QUALITATIVE INTERPRETATION OF THE RESIDUAL BOUGUER ANOMALIES*

The residual gravity map shows a local isolated high gravity in the center part of the study area. Some of these anomalies are linear trends such as a dyke structure striking in NW-SE direction. Amplitudes of these high gravity anomalies range from 0.11 to 0.43 mGal and are correlated with high magnetic anomalies probably due to mafic intrusions (refer to the figure 7). Approximate location of the quartz veins style mineralization, which was provided by the client, is displayed on the *Geophysical Interpretation Map (10.0)*. This zone cannot be identified with confidence because it is narrow and the gravity data sampling is large (25 m).

In order to outline the mineralization zones, a gradient configuration can be applied as a first stage and a dipole-diplole configuration (a = 25 m and n = 1 to 8) can be used as a second stage.

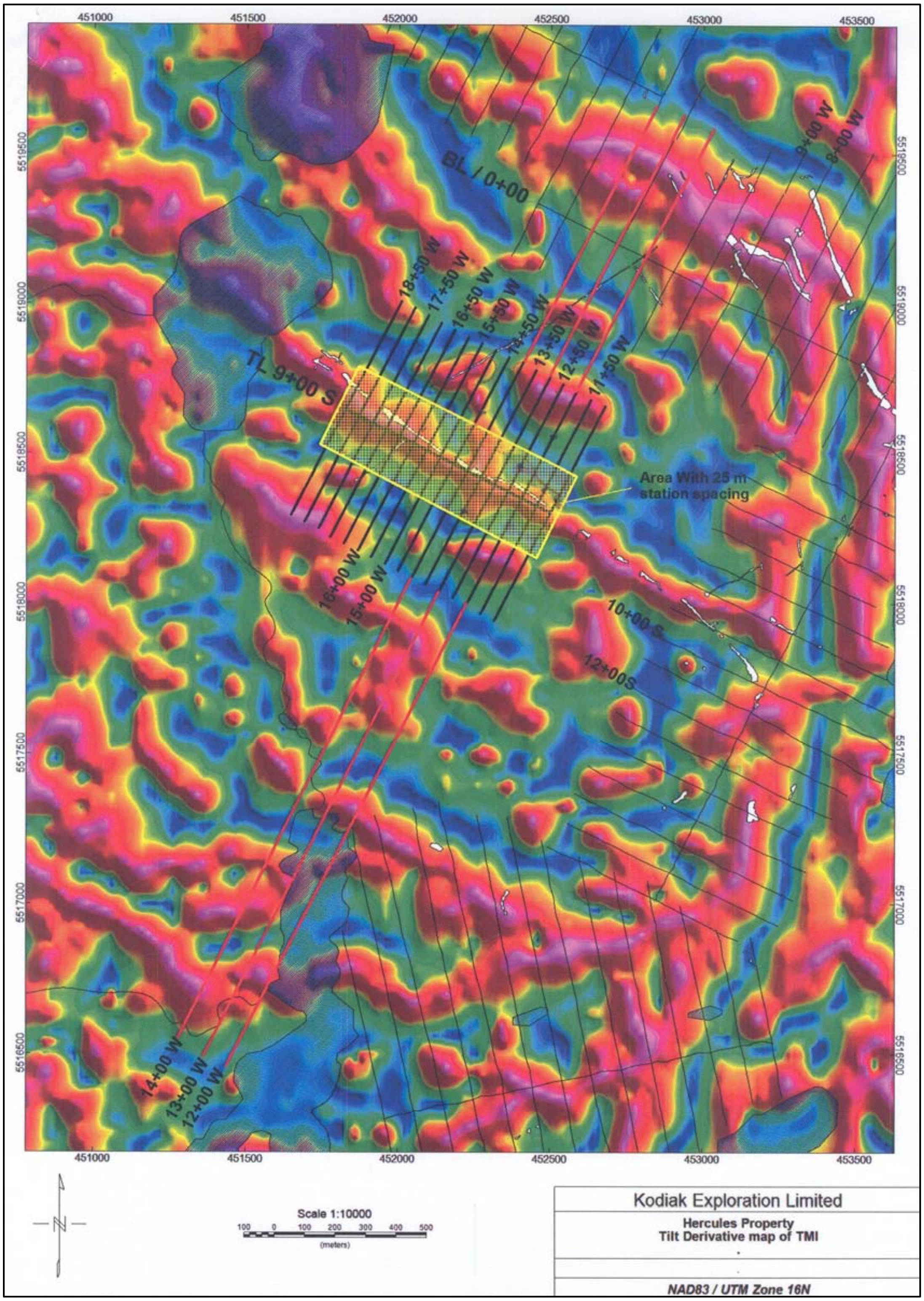


FIGURE 7: TILT DERIVATIVE OF TMI OVER THE KINGHORN PROPERTY

The interpretation of the geophysical data embodied in this report is essentially a geophysical appraisal of the Central Golden Mile project. As such, it incorporates only as much geoscientific information as the author has on hand at the time. Geologists thoroughly familiar with the area are in a better position to evaluate the geological significance of the various geophysical signatures. Moreover, as time passes and information provided by follow-up programs are compiled, exploration targets recognized in this study might be downgraded or upgraded.

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MC/